

Surgical reconstruction of iliofemoral veins and the inferior vena cava for nonmalignant occlusive disease

Corey J. Jost, MD,^a Peter Gloviczki, MD,^a Kenneth J. Cherry, Jr, MD,^a Michael A. McKusick, MD,^b William S. Harmsen, MS,^c Greg D. Jenkins, BS,^a and Thomas C. Bower, MD,^a Rochester, Minn

Purpose: Venous reconstructions are rarely performed, and factors affecting long-term results of bypass grafts implanted in the venous system are not well defined. In this report we updated our experience.

Methods: The clinical data of all patients who underwent venous reconstruction for iliofemoral or inferior vena caval (IVC) occlusion due to nonmalignant disease between January 1985 and June 1999 were retrospectively reviewed. Patients were classified, and outcomes were compared according to the guidelines of the Joint Vascular Societies.

Results: Forty-two patients, 23 males and 19 females (mean age, 40 years; range, 16-81), underwent 44 venous reconstructions. Thirty-six patients had limb swelling or venous claudication, 38 had pain, and 14 had healed or active ulcers. The cause of obstruction was congenital in two and acquired in 40 (deep vein thrombosis, 25; trauma, 5; retroperitoneal fibrosis, 4; IVC occlusion devices, 4; others, 2). Eighteen patients underwent saphenous vein crossover grafts (Palma procedure), 17 had expanded polytetrafluoroethylene (ePTFE) grafts implanted (femorocaval, 8; ilio-caval, 5; crossfemoral, 3; cavoatrial, 1), 6 patients had spiral vein grafts (5 iliac/femoral and 1 cavoatrial), and 1 underwent femoral vein patch angioplasty. Clinical follow-up averaged 3.5 years (median, 2.5), and graft follow-up with imaging studies averaged 2.6 years (median, 1.6). Seven patients were lost to follow-up. The secondary 3-year patency rate for all reconstructions was 62%. Palma procedures had a 4-year patency rate of 83%. The secondary patency rate of ilio-caval and femorocaval ePTFE bypass grafts at 2 years was 54%. The secondary patency was lower in patients with an arteriovenous fistula ($P = .023$). All ePTFE grafts had a 45% patency rate at 2 years, not significantly different from saphenous vein grafts (83%, $P = .16$). Clinical scores improved with graft patency (median, 0.0 vs 1.5; $P = .044$).

Conclusions: Venous reconstructions for iliofemoral or IVC obstruction offer 3-year patency rates of 62%. The Palma procedure with autologous saphenous vein had the best long-term patency, whereas long-term success with ePTFE was moderate. The use of an arteriovenous fistula to improve graft patency remains controversial. (J Vasc Surg 2001;33:320-8.)

Patients with chronic occlusion of the inferior vena cava (IVC) or the iliofemoral veins may present with various symptoms, ranging from mild discomfort to severe disability, including limb swelling and aching or thigh and buttock pain, which is induced by exercise (venous claudication). Signs of venous outflow obstruction include limb swelling, varicosities, and a range of skin changes including ulceration. Attempts to reconstruct venous outflow obstruction include surgical bypass grafts and endovascular techniques with angioplasty and stents.¹⁻⁷ Factors affecting the success of venous surgical bypass grafts are still not well defined.

We previously reported results of large vein reconstructions performed at our institution for both benign and malignant disease.⁸⁻¹¹ Patients with malignant disease

have excellent long-term patency, but a short life expectancy because of the underlying malignancy. In this report, we updated our experience with patients who underwent venous reconstructions for benign iliofemoral or IVC occlusion or for venous trauma in the past 15 years. We analyzed long-term patency and clinical outcomes to identify factors predicting the success of surgical reconstructions.

PATIENTS AND METHODS

We retrospectively reviewed the clinical course and outcome of 42 patients who underwent venous reconstruction for iliofemoral or IVC occlusion caused by non-malignant disease at our institution between January 1, 1985, and June 30, 1999. There were 43 patients who had venous reconstructions performed during this period for this indication, but one patient denied research authorization. Data for 15 of these patients with shorter follow-up have been previously reported.^{8,9} During the same period, 1639 operations for varicose veins and 96 subfascial endoscopic perforator surgery procedures were performed at the Mayo Clinic.

Clinical presentation and results of preoperative evaluation, including venous pressure measurements and functional studies, were reviewed and recorded. All available imaging studies were reviewed.

From the Division of Vascular Surgery,^a the Department of Diagnostic Radiology,^b and the Section of Biostatistics,^c Mayo Clinic.

Competition of interest: nil.

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Peter Gloviczki, MD, Mayo Clinic, 200 First Street SW, Rochester, MN 55905 (e-mail: gloviczki.peter@mayo.edu).

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Fig 1. Digital subtraction venogram of left lower extremity and pelvis showing a patent left to right Palma graft 6 months after operation (*dark arrow*). Left iliac vein stent (*white arrow*) thrombosed before operation.

Follow-up imaging studies were performed in all patients, and the end point of patency was defined as patent or occluded at the last imaging study (average, 2.6 years; median, 1.6 years; range, 1 month to 11.7 years). The last imaging study was venography (13) or ultrasound scan (29) (Figs 1 and 2). Primary patency was defined as no graft intervention for graft occlusion (surgical or endovascular), and secondary patency was defined as any graft intervention resulting in graft patency. The average duration of clinical follow-up was 3.5 years (median, 2.5; range, 0.1-11.7), and information was obtained from a questionnaire up to a mean of 6 years (median, 7.1; $n = 34$; range, 0.6-11.6). Seven patients were lost to follow-up; however, information on graft patency in these patients was available at a mean of 25 months after operation (range, 10-62 months). Three patients died in the follow-up period of unrelated causes, and on two patients, follow-up information was available and complete.

The guidelines of the Joint Vascular Societies (CEAP classification) were used for classification and scoring clinical outcome, and disability.¹² The clinical severity score^{12a} and outcome score¹² (asymptomatic, 3; moderate improvement, 2; mild improvement, 1; unchanged, 0; mildly worse, -1; moderately worse, -2; and severely worse, -3) were used to assess clinical benefit. Outcome scoring was obtained in 34 patients (81%). The clinical factors of smoking, a clinical class more than 3, the presence of distal venous reflux, a history of deep venous thrombosis (DVT), obesity, diabetes, a history of limb trauma, hypercoagulability, and operative and anatomic factors were analyzed for associations with graft occlusion.



Fig 2. Patent left femorocaval ePTFE bypass graft in a 54-year-old woman 11.7 years after graft placement (*arrow*).

Estimates of primary and secondary patency were calculated with the Kaplan-Meier survival method.¹³ The 95% CIs are given for these estimates. Patency between patient groups was compared with the log-rank test.¹⁴ For clinical outcome measures at last follow-up, the patients with occlusion and those without occlusion were compared with the Wilcoxon rank sum test. Results were considered statistically significant with a P value of .05 or less. Because of the small number of patients in several subgroups, the power of statistical analyses was limited.

RESULTS

Forty-two patients (23 males, 19 females) with a mean age of 40 years (range, 16-81) underwent 44 venous reconstructions for nonmalignant occlusion of the iliofemoral veins or IVC. Signs and symptoms of venous hypertension were limb swelling or venous claudication in 36 patients; 38 had pain, 5 had healed ulcers (Class 5), and 9 had active ulcers (Class 6). Thirty-seven patients (88%) were in Classes 3 to 6. Four patients had acute venous trauma (Class 0) (Table I).

The etiology of venous obstruction was congenital in two patients and acquired in 40. Secondary causes included chronic persistent venous thrombosis in 25 patients, trauma in 5 (3 iatrogenic and 2 gunshot wounds), retroperitoneal fibrosis in 4, DVT associated with IVC occlusion devices in 4 (1 Hunter's balloon, 1 Miles' clip, and 2 ligations), and suprarenal caval occlusion in 2 (1 web and 1 IVC coarctation) (Fig 3). Risk factors for DVT included a previous DVT in 34 patients, smoking in 21, obesity in 14, a history of limb trauma in 14, and a prethrombotic state in 5.

Preoperative conservative management included intermittent leg elevation (35 patients), graded compression stockings (31 patients), diuretics (10 patients), and Unna boots or intermittent pneumatic compression pump (3 patients each). Previous surgical interventions in 12

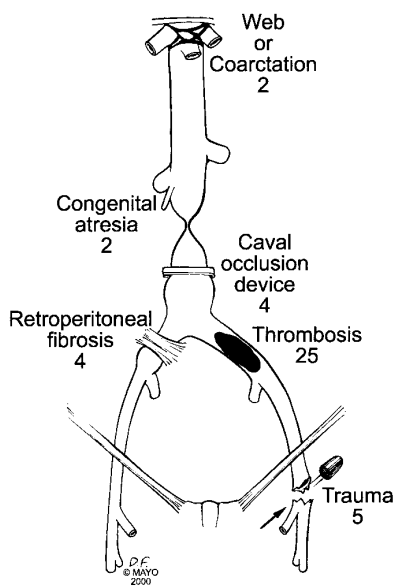


Fig 3. Etiology of venous occlusion in the 42 patients studied. Reprinted by permission from the Mayo Foundation.

patients included vein stripping in 5, iliac vein angioplasty with stenting in 3, angioplasty alone in 1, skin grafting in 2, and previous venous reconstruction in 2.

Thirty patients had preoperative venous functional studies: 18 underwent strain gauge plethysmography (Phlebotest; Eureka, Stockholm, Sweden), and 12 had impedance plethysmography. Twenty-five patients (83%) had abnormal results from the studies, suggesting venous outflow obstruction (> 4 -second venous drainage times or abnormal impedance tracings). Twelve (57%) of 22 patients had plethysmographic evidence of associated venous incompetence as noted by abnormal refill rates (< 5 seconds) or positive exercise venous plethysmography.¹⁵

Preoperative imaging included contrast venography in 38 patients and computed tomography with intravenous contrast in 10. Duplex scan was used to assess for reflux in 30 patients. Thirty-two patients had iliofemoral venous occlusion (21 left and 11 right), 6 had iliocaval occlusions, and 4 were isolated to the IVC. The pathophysiology of venous disease involved obstruction alone in 20 (48%) and a combination of obstruction and distal reflux in 22. Twelve of 14 patients with Class 5 and Class 6 disease had both reflux and obstruction. Incompetent perforating veins were noted in seven patients preoperatively.

Surgical indications for venous reconstruction included symptomatic venous occlusion despite conservative management or acute venous injury. Eighteen patients underwent saphenous vein crossover grafts (Palma procedure), 17 had externally supported expanded polytetrafluoroethylene (ePTFE) grafts implanted (femorocaval, 8; iliocaval, 5; crossfemoral, 3; cavaatrial, 1), 6 had spiral vein grafts (5 iliac/femoral and 1 cavaatrial), and 1 had a femoral vein patch angioplasty (Figs 4 and 5). A distal

Table I. Clinical classification

Clinical class	Preoperative*		Postoperative†	
	No	(%)	No	(%)
C0-no signs	4	9.5	4	12
C1-reticular veins	0	0	0	0
C2-varicosities	1	2.4	0	0
C3-edema	19	45.2	12	35
C4-skin changes	4	9.5	7	21
C5-healed ulcer	5	11.9	9	26
C6-active ulcer	9	21.4	2	6

*n = 42.

†n = 34.

arteriovenous fistula (AVF) was added at the initial procedure in 20 patients (48%) and at reoperation in an additional four.

Graft flows were measured with an electromagnetic flow meter that ranged from 20 to 3000 mL/min (mean, 349; median, 80) without an AVF and 125 to 2200 mL/min (mean, 571; median, 300) with an AVF (n = 22). The median prereconstruction femoral/central (femorofemoral in patients with unilateral disease) venous pressure gradient was 10 mm Hg (range, 1-37; n = 25), and it decreased to a median of 4 mm Hg (range, 0-18 mm Hg; n = 24) as measured intraoperatively after reconstruction. Pressures were measured in the supine patient, and adjuncts such as tourniquets or drugs were not used during the study.

Intraoperative anticoagulation was used in all patients with 5000 units of intravenous heparin, with an additional dose given if the activated clotting time was less than twice the normal time. Patients continued to receive 500 U/h of heparin infusion, either through a catheter placed into the saphenous or femoral veins and advanced to the proximal anastomosis or through a peripheral or central line. All but one patient were discharged while receiving oral anticoagulation. Patients were fitted with thigh-high graded compression stockings of 30 to 40 mm.

There was no early death, and there were no acute clinically evident DVTs or pulmonary emboli. Early graft occlusion occurred in eight patients (19%). Other complications included bleeding that required surgical evacuation of hematoma or transfusion in five patients (12%) and local wound infections in three (7%). Twenty-one secondary procedures were performed, 8 were within 30 days of grafting, and 13 occurred later during follow-up. Early interventions included thrombectomy in 6 patients (4 with the addition of an AVF), graft revision in 1, and wound exploration for hematoma in 1.

The primary patency rate at 30 days for all reconstructions was 81%, and secondary patency rate was 93%. Of the 42 patients, 39 (93%) had a patent graft (38) or venous reconstruction (1 patch angioplasty) at discharge.

Late graft patency

For all reconstructions, the overall 3-year primary and secondary patency rates were 54% (CI, 40%-75%) and 62%

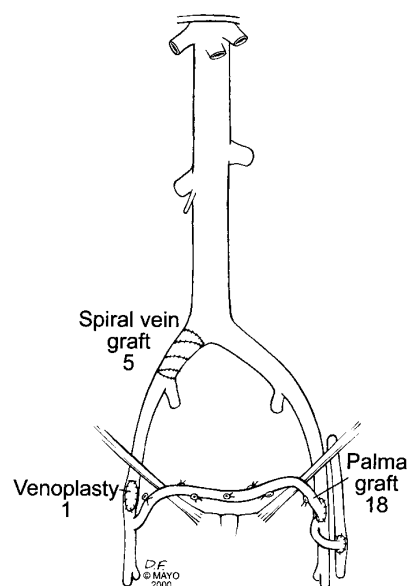


Fig 4. Methods for reconstruction of the IVC and iliofemoral veins with autologous vein. Reprinted with permission from the Mayo Foundation.

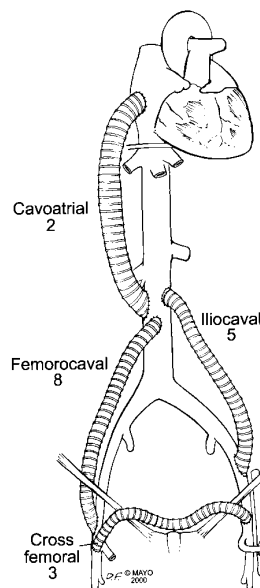


Fig 5. Prosthetic reconstructions (ePTFE). Reprinted with permission from the Mayo Foundation.

(CI, 48%-82%), respectively (Fig 6). Of the 42 venous reconstructions, 25 (60%) were patent at last imaging study (mean, 2.6 years; median, 1.6; range, 0.1-11.7).

Femorofemoral saphenous vein grafts (Palma procedure). Four-year primary and secondary patency rates of 18 saphenous vein crossover grafts were 77% (CI, 60%-100%) and 83% (CI, 67%-100%), respectively. Thirteen grafts (72%) were patent at last imaging, at an average of 2 years (median, 1.3; range, 4 months to 9.8 years). Three of 12 Palma grafts without an initial AVF failed, compared with two failures of six with an initial AVF (P = not significant). Three failing Palma grafts had AVFs added at a secondary procedure, with preservation of patency in one.

Iliocaval and femorocaval bypass grafts. The primary and secondary patency rates of 13 iliocaval (n = 5) and femorocaval (n = 8) bypass grafts at 2 years were 38% (CI, 19%-76%) and 54% (CI, 33%-89%), respectively. Two iliocaval bypass grafts occluded, one at 2 months and the other at 1 year. Five of eight femorocaval grafts failed at 0.2, 9, 15, 15, and 22 months (mean, 12 months). The patency rate of iliocaval and femorocaval grafts (54%) was not significantly different from that of Palma grafts (83%) at 2 years (P = .3, Fig 7).

Spiral vein grafts. Four (67%) of six grafts were patent at 2, 2, 4, and at 10 months after reconstructions.

Cavoatrial grafts. Two cavoatrial bypass grafts, 1 ePTFE, and 1 spiral vein graft (mentioned previously), were performed. The ePTFE graft was patent at 1 year, and the spiral graft occluded at 3 months.

Crossfemoral ePTFE grafts. All three ePTFE grafts occluded early at 1, 2, and 12 months, despite an adjunctive AVF.

Intraoperative factors for graft occlusion

Greater saphenous vein reconstructions had better secondary patency than grafts with ePTFE (difference approaching significance, P = .095). The use of an adjunctive AVF was significantly associated with higher graft loss (P = .010). This association remained significant when graft salvage or delayed AVF was excluded from the comparison (P = .023).

Patient risk factors for graft occlusion

Patient factors were also evaluated to determine causes of graft failure. No statistically significant associations were found with any patient factor. These subgroups were small, resulting in a high SE and limited comparison. However, smokers had a 39% lower patency rate at 2 years when compared with nonsmokers (46% versus 85% at 2 years, P = .097). Twenty-one patients had concomitant infrainguinal venous occlusive disease, and 10 of these patients had graft occlusion. Sixteen patients had concomitant infrainguinal reflux, and six had graft occlusions. Nine patients with Palma grafts had concomitant infrainguinal venous occlusion; only two of these grafts have failed.

Clinical outcome

Thirty-four patients were available for assessment of benefit of venous reconstruction at a mean of 6 years. Four (12%) patients had no signs of venous disease, 12 (35%) had persistent swelling, and only 2 (6%) had active ulcers (Table I).

Outcome score improved for the entire group, to an average score of 1 (mild improvement).^{12a} Median outcome score improved in patients with patent reconstructions (2,

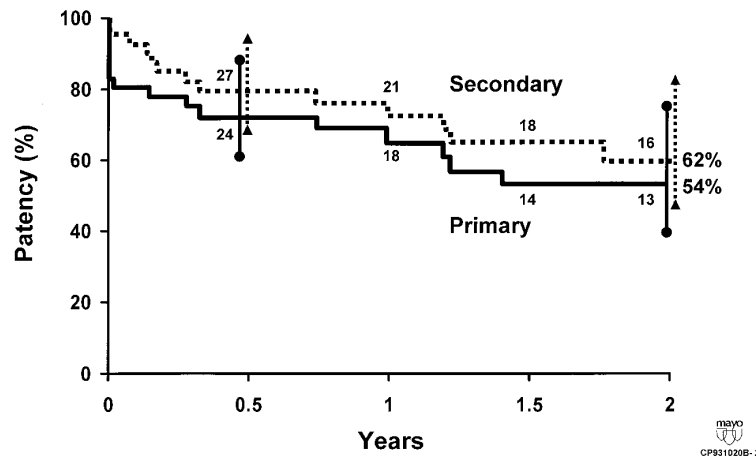


Fig 6. Cumulative primary and secondary patency rates of 42 venous reconstructions.

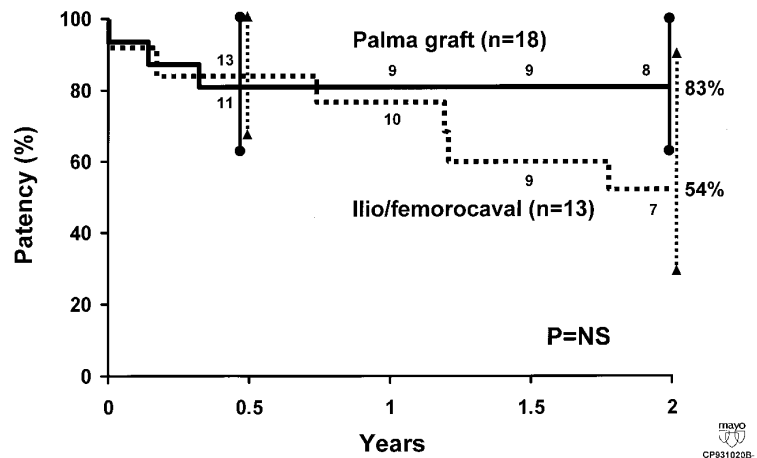


Fig 7. Cumulative secondary patency rates of saphenous vein crossover bypass grafts (Palma procedure) and ePTFE iliofemoral and femorocaval bypass grafts.

moderate improvement; range 0-3), as compared with those with failed grafts (0, no change; +2 to -2, $P < .01$).

Mean preoperative clinical severity score was 7 ($n = 38$; range, 0-16), and mean postoperative score was 5.7 ($n = 34$; range, 1-16, NS). Improvement in clinical score was significantly better in patients with patent grafts ($n = 16$; mean, 3.6; median, 1.5; range, 4 to -13), as compared with those with occluded grafts ($n = 13$; mean, 1.4; median, 0.0; range, 9 to -4; $P = .44$; patients with acute venous trauma excluded $n = 5$). Of patients with patent reconstructions, nine had improvement (56%), and seven noted no change or worsening scores (44%). Of those with graft occlusion five noted improvement (38%), and eight had no change or worsening scores (62%). Disability scores did not improve (2.7 preoperative, 2.0 postoperative, NS).

Postoperative noninvasive venous studies showed improvement in only two of 12 patients studied with impedance plethysmography. Strain-gauge plethysmogra-

phy was performed postoperatively in 18 patients, and in no patients did the 4-second venous drainage fraction return to a normal value of more than 60%. The mean time to plethysmographic investigation was 3.1 months (median, 3.0; range, 5 days to 4.5 years). Of these seven, the incidence of associated venous reflux was noted to be less than the entire surgical cohort (43% vs 52%).

Late surgical interventions included ligation of an AVF in 9 patients, graft revisions in 2, thrombectomy in 1, and balloon angioplasty in 1. AVF closure in nine of 24 patients was performed, on average, at 9 months (range, 48 days to 1.5 years). Three patients died during follow-up. One patient died of complications caused by a fall at the age of 92 (11 years after reconstruction), and the other two patients died because of transplant failure (1 kidney and 1 liver).

DISCUSSION

Surgical reconstructions for venous occlusive disease

Table II. Results of femorofemoral saphenous vein crossover bypass graft (Palma procedure)

First author	Year	No. of limbs	Follow-up (y)	Imaging follow-up	Patency (%)	Clinical improvement (%)
Palma ²⁰	1960	8	Up to 3	13	n/a	88
Dale ²⁵	1979	48	Up to 12	n/a	n/a	77
May ²⁶	1981	66	n/a	n/a	73	n/a
Dale ²⁷	1983	56	n/a	n/a	n/a	80
Husni ²	1983	85	0.5-15	n/a	70	74
Halliday ³	1985	47	Up to 18	72	75 (5 y)	89
Danza ²⁸	1991	27	n/a	n/a	n/a	81
AbuRahma ²⁹	1991	24	5.5	100	75 (7 y)	63
Gruss ³⁰	1997	19	n/a	n/a	71	82
Jost	2000	18	0.1-9.1	100%	82 (4 y)	67
Total		398			74	78

Adapted with permission from Glociczki P, Cho JS. Surgical treatment of chronic deep venous obstruction. In: Rutherford RB, editor. Vascular surgery. 5th ed. Philadelphia: WB Saunders Co; 2000. p. 2049-66.

n/a, Not available.

are rarely performed. Consequently, reliable data on long-term patency, clinical outcome, and risk factors for graft occlusion are scant. With the availability of minimally invasive endovascular techniques, indications for and results of surgical treatment have to be scrutinized to provide the patient with realistic options for treatment of venous outflow obstructions.

Endovascular stents have been used with increasing frequency for the treatment of iliac vein occlusion.^{7,16-19} Initial experience has been favorable, although failures are not uncommon. Three of the patients reported here had bypass grafts performed after failed iliac stents were placed in them at other institutions.

In the last 40 years various surgical operations have been used to treat patients with caval or iliofemoral venous occlusive disease. In 1958, Palma was the first to use a crossfemoral saphenous veno-venous bypass graft for unilateral iliac vein obstruction.²⁰ The Palma procedure was popularized further in this country by Dale¹ and was successfully used later by others.²⁻⁶ There have also been small series of patients reported in whom reconstructions were performed with prosthetic materials for direct femoral and ilio caval replacement.²¹⁻²³ All of these reports of venous reconstruction had highly variable reporting standards. Eklof et al²⁴ have rightly criticized the reports for being anecdotal, having variable surgical criteria, lacking objective follow-up, and having poor life-table patency analysis. Our report does attempt to overcome these criticisms. However, the number of patients in the different groups of reconstructions was low, and statistical analysis was limited in most subgroups. Most important, our follow-up with imaging studies was short; it averaged only 2.6 years. Information on clinical outcome with a longer follow-up could be obtained on most patients; however, this information was not used to evaluate the grafts' patency.

The Palma procedure has been reported by others to have patency rates of 70% to 85% and clinical improvements in 63% to 88% of patients after reconstruction.^{2,3,20,25-31} In a report by AbuRahma et al,²⁹ imaging studies were performed at follow-up in all patients, and the 7-year cumulative patency rate was 75%. However, the

SE in this study was high, and only a small number of patients were followed up beyond 5 years. Our results confirm this with similar findings of a 4-year patency rate of 83% in Palma reconstructions (Table II). Sixty-seven percent of these patients also noted clinical improvement by outcome score. Therefore, the Palma procedure continues to be our first treatment option for patients with symptomatic unilateral iliac vein occlusion.

Graft material for large vein reconstruction continues to be a problem, because the saphenous vein is frequently small or diseased. In such cases the remaining options for venous reconstruction include vascular prosthesis, arm vein, or homograft. Lalka et al³² reported a mathematical advantage for the use of ePTFE in crossfemoral venous reconstructions. However, prosthetic grafts for venous reconstruction have been noted to have a lower patency because of increased thrombogenicity coupled with lower flow rates in the venous system.³³ Encouraged by the excellent results (85% patency rate) of Gruss and Hiemer,³⁰ we have attempted ePTFE crossfemoral grafts in three patients, without success. The number in this group remains low, and we do not have enough data to comment on the use of PTFE crossfemoral grafts. In contrast, direct ilio caval or femorocaval reconstructions in our patients resulted in a 54% cumulative patency rate at 2 years, and 64% of patients noted clinical improvement. Others have reported that iliac and femoral direct reconstructions have patency rates of 88% to 100%.^{22,23}

The alternative to prosthetic reconstruction is the use of spiral vein grafts. If vein is available, a short spiral vein graft may be the right choice for replacement of a short segment of an injured femoral or iliac vein. External compression of the graft and length limitations restrict the use of spiral vein grafts for ilio caval and femorocaval applications.

The use of an AVF is a debated topic in the literature, with pros and cons discussed in experimental and clinical reports.^{33,34} Our findings could be construed to suggest that an AVF might have a negative effect on patency. We used AVF selectively in patients who were at high risk for graft failure because of low flow in the vein graft or the use of a prosthetic graft in an unfavorable position (long femorocaval,

iliocaval, or femorofemoral PTFE). Because these patients have the highest risk of graft thrombosis, it is not surprising that we found a higher rate of graft failure in this group. We currently use an AVF for Palma grafts under these conditions: graft flow less than 100 mL/min, saphenous vein less than 5 mm in diameter, or an intraoperative pressure gradient less than 5 mm Hg. Large Palma grafts with flows above 100 mL/min are done without an AVF. We continue to use AVF for all femorocaval and all longer iliocaval ePTFE grafts. The fistula is taken down at 3 months for Palma grafts and at 6 to 9 months in ePTFE grafts. When the patient has good clinical results and no ill effects from the AVF, we occasionally leave the AVF in indefinitely.

Successful revascularization resulted in improved clinical outcome, as measured with the clinical severity score. Also, the patients' own perception of their condition improved significantly, as noted with outcome scoring, when we compared those who had patent grafts with those who had failed grafts. There is increasing evidence that venous reconstruction gives durable results, and with patency there are lasting improvements in clinical markers of disease regression and patient satisfaction in most patients. We suspect that severe infrainguinal occlusion or valvular incompetence is the cause of disease progression despite a patent reconstruction, in a minority of patients.

Noninvasive plethysmographic data confirmed the presence of venous obstruction or reflux preoperatively and helped in the selection of patients for contrast venography. However, plethysmographic data were not helpful for following graft patency. The failure of reconstruction to improve venous drainage fraction might be due to distal venous obstruction in the deep venous system or the presence of venous hypertension induced by an AVF. These confounding factors limit the value of strain-gauge plethysmography as a postoperative screening tool for graft occlusion. Currently, we recommend duplex ultrasound scan for graft surveillance, at 3, 6, and 12 months postoperatively and then every 6 months for life.

In conclusion, our experience with large vein reconstruction suggests that surgical bypass grafting for nonmalignant venous occlusion of the IVC and iliac and femoral venous systems has a role in a select group of symptomatic patients. Venous reconstruction offers reasonable (62%) 3-year patency, with associated clinical improvements. The Palma procedure with the use of autologous saphenous vein had the best long-term patency rate, 83% at 4 years, whereas the long-term success with ePTFE was only moderate. The use of an AVF to improve patency remains controversial.

REFERENCES

1. Dale WA. Venous bypass surgery. *Surg Clin North Am* 1982;62:391-8.
2. Husni EA. Reconstruction of veins: the need for objectivity. *J Cardiovasc Surg* 1983;24:525-8.
3. Halliday P, Harris J, May J. Surgery of the veins. In: Bergan JJ, Yao JST, editors. *Femoro-femoral cross over grafts (Palma operation): a long-term follow-up study*. Orlando: Grune & Statton; 1985.
4. O'Donnell TFJ, Mackey WC, Shepard AD, Callow AD. Clinical, hemodynamic, and anatomic follow-up of direct venous reconstruction. *Arch Surg* 1987;122:474-82.
5. Raju S, Fredericks R. Venous obstruction: an analysis of one hundred thirty-seven cases with hemodynamic, venographic, and clinical correlations. *J Vasc Surg* 1991;14:305-13.
6. Gloviczki P, Pairolero PC, Toomey BJ, Bower TC, Rooke TW, Stanson AW, et al. Reconstruction of large veins for nonmalignant venous occlusive disease. *J Vasc Surg* 1992;16:750-61.
7. Elson JD, Becker GJ, Wholey MH, Ehrman KO. Vena caval and central venous stenoses: management with Palmaz balloon-expandable intraluminal stents. *J Vasc Interv Radiol* 1991;2:215-23.
8. Gloviczki P, Pairolero PC, Cherry KJ, Hallett JW Jr. Reconstruction of the vena cava and of its primary tributaries: a preliminary report. *J Vasc Surg* 1990;11:373-81.
9. Rhee RY, Gloviczki P, Luthra HS, Stanson AW, Bower TC, Cherry KJ Jr. Iliocaval complications of retroperitoneal fibrosis. *Am J Surg* 1994;168:179-83.
10. Bower TC, Nagorney DM, Toomey BJ, Gloviczki P, Pairolero PC, Hallett JWJ, et al. Vena cava replacement for malignant disease: is there a role? *Ann Vasc Surg* 1993;7:51-62.
11. Bower TC, Nagorney DM, Cherry KJ Jr, Toomey B, Hallett JW Jr, Panneton JM, et al. Replacement of the inferior vena cava for malignancy: an update. *J Vasc Surg* 2000;31:270-81.
12. Porter JM, Moneta GL. Reporting standards in venous disease: an update. International Consensus Committee on Chronic Venous Disease. *J Vasc Surg* 1995;21:635-45.
13. Nicolaidis AN, et al. Classification and grading of chronic venous disease in the lower limbs: a consensus statement. In: Gloviczki P, Yao JST, editors. *Handbook of venous disorders: guidelines of the American Venous Forum*. London: Chapman and Hall Medical; 1996. p. 652-60.
14. Kaplan ER, Meier P. Nonparametric estimation from incomplete observations. *Journal of the American Statistical Association* 1958;53:457-81.
15. Peto R, Peto J. Asymptotically efficient rank invariant procedures. *Journal of the Royal Statistical Association* 1972;135:185-207.
16. Rofors S, Ahlstrom H, Boccalon H, Nilsson S, Partsh H, Rooke TW, et al. Computerized strain-gauge plethysmography using a capacitance mode in the diagnosis of deep venous thrombosis. *Scope of Phlebology and Lymphology* 1996;2:8-12.
17. Blattler W, Blattler IK. Relief of obstructive pelvic venous symptoms with endoluminal stenting. *J Vasc Surg* 1999;29:484-8.
18. Heniford BT, Senler SO, Olsofka JM, Carrillo EH, Bergamini TM. May-Thurner syndrome: management by endovascular surgical techniques. *Ann Vasc Surg* 1998;12:482-6.
19. Mickley V, Schwagierek R, Riling N, Gorich J, Sunder-Plassmann L. Left iliac venous thrombosis caused by venous spur: treatment with thrombectomy and stent implantation. *J Vasc Surg* 1998;28:492-7.
20. Binkert CA, Schoch E, Stuckmann G, Largiader J, Wigger P, Schoepke W, et al. Treatment of pelvic venous spur (May-Thurner syndrome) with self-expanding metallic endoprostheses. *Cardiovasc Intervent Radiol* 1998;21:22-6.
21. Palma EC, Esperon R. Vein transplants and grafts in the surgical treatment of the postphlebotic syndrome. *J Cardiovasc Surg* 1960;1:94-107.
22. Raju S. New approaches to the diagnosis and treatment of venous obstruction. *J Vasc Surg* 1986;4:42-54.
23. Alimi YS, DiMauro P, Fabre D, Juhan C. Iliac vein reconstructions to treat acute and chronic venous occlusive disease. *J Vasc Surg* 1997;25:673-81.
24. Dale WA, Harris J, Terry RB. Polytetrafluoroethylene reconstruction of the inferior vena cava. *Surgery* 1984;95:625-30.
25. Eklof BG, Kistner RL, Masuda EM. Venous bypass and valve reconstruction: long-term efficacy. *Vasc Med* 1998;3:157-64.
26. Dale WA. Reconstructive venous surgery. *Arch Surg* 1979;114:1312-8.
27. May R. The Palma operation with Gottlob's endothelium preserving suture. In: May R, Weber J, editors. *Pelvic and abdominal veins: progress in diagnosis and therapy*. Amsterdam: Excerpta Medica; 1981. p. 192-7.
28. Dale WA. Crossover vein grafts for iliac and femoral venous occlusion. *Resident and Staff Physician* 1983;29:58-63.
29. Danza R, Navarro T, Baldizan J. Reconstructive surgery in chronic venous obstruction of the lower limbs. *J Cardiovasc Surg* 1991;32:98-103.
30. AbuRahma AF, Woodruff BA, Lucente FC, Stuart SP, Boland JP. Factors affecting survival of patients with ruptured abdominal aortic aneurysm in a West Virginia community. *Surg Gynecol Obstet* 1991;172:377-82.

30. Gruss JD, Hiemer W. Bypass procedures for venous obstruction: Palma and May-Husni bypasses, Raju perforator bypass, prosthetic bypasses, and primary and adjunctive arteriovenous fistulae. In: Raju S, Villavicencio JL, editors. *Surgical management of venous disease*. Baltimore: Williams & Wilkins; 1997. p. 289-305.
31. Gloviczki P, Cho JS. Surgical treatment of chronic deep venous obstruction. In: Rutherford RB, editor. *Vascular surgery*. 5th ed. Philadelphia: WB Saunders Co; 2000. p. 2049-66.
32. Lalka SG, Lash JM, Unthank JL, Lalka VK, Cikrit DF, Sawchuk AP, et al. Inadequacy of saphenous vein grafts for crossfemoral venous bypass. *J Vasc Surg* 1991;13:622-30.
33. Plate G, Hollier LH, Gloviczki P, Dewanjee MK, Kaye MP. Overcoming failure of venous vascular prostheses. *Surgery* 1984;96:503-10.
34. Menawat SS, Gloviczki P, Mozes G, Whitley D, Anding WJ, Serry RD. Effect of a femoral arteriovenous fistula on lower extremity venous hemodynamics after femorocaval reconstruction. *J Vasc Surg* 1996;24:793-9.

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DISCUSSION

Dr William C. Krupski (Denver, Colo). Dr Hobson, Dr Riles, members, and guests.

I congratulate Dr Jost for an outstanding presentation. The Mayo Clinic group is legendary for its extensive experience in treating venous disease. For that matter, reports of that institution consistently describe enormous numbers of patients, often the largest series of any given disorder. In that tradition, today's description of 42 patients undergoing 44 reconstructions of the venous system over a 14-year period is an impressive collection of cases. I tell the residents that often such papers can be labeled "Look how good I can do it" articles, reporting results that seemingly cannot be duplicated by others. The presentation today is refreshing in that the authors have described bad outcomes as well as good ones, with only one in two patients enjoying 3-year graft patency.

To say this series of patients is an understatement. In their zeal to give us large numbers of patients to guide our practices, the authors have combined apples, oranges, and pomegranates. Some patients had Palma procedures, some had spiral vein grafts, some had femoral or iliofemoral PTFE grafts, some had PTFE crossfemoral grafts, and one or two patients had other procedures. Some patients had adjunctive arteriovenous fistulas, some didn't, and some had salvage AV fistulas. Some patients had measurements of preoperative and postoperative pressure gradients and flow, and some didn't. Although almost all patients had postoperative anticoagulation, we are provided no information regarding therapeutic INRs. When I tried to tie all this into a treatment algorithm, I'm afraid I became hopelessly confused.

The Palma operation seemed to work well. In the 18 patients who were candidates for this operation, 4-year patency was 82%. Except for this operation, however, I fear I would not be enthusiastic about offering one of my patients any of these procedures. Although one in two patients having other operations may enjoy 3-year patency, it is unclear how to choose which of the two patients will benefit. I am left with Dr Wylie's former teaching: "Don't operate on veins except to remove the varicose ones."

Much ado is made in this presentation about the correlation of clinical improvement and patency rates. I would point out, however, that the patients could not be blinded to their own patency data. A patient can see and hear the duplex or venogram results of his or her postoperative study, and it would be a natural tendency for those patients with patent reconstructions to think they are doing better, whereas for those with failed grafts to assume they are doing poorly. The thinking goes "My graft has occluded, so I must be worse." In that regard, the authors admit that only a fraction of patients studied had objective improvement in venous function by impedance plethysmography.

Finally, my greatest criticism of this report is the absence of any type of control group. Of over 8000 patients seen at the Mayo Clinic for venous insufficiency during the study period, 73 were identified to have venous obstruction. We are not informed how many of the 8000 had venous imaging studies. It is hard to believe that only 73 of the 8000 had venous obstructions. Slightly over half of the 73 patients identified underwent operation. The authors provide no guidance regarding how they chose to operate and not operate on these patients. Importantly, they provide no

information about those patients who were treated nonoperatively. I would argue that optimization of conservative management might have provided comparable improvement in clinical scores.

I would like Dr Jost to address the criticisms I have raised. And I have only one specific question for him. What would you recommend that we do with the middle-aged active patient who has significant leg swelling, moderate discomfort, but no active ulcers, and ultrasound findings of occlusion of the ipsilateral iliac, common femoral, and proximal superficial vein? Should we operate? And if so, exactly what operation should we perform?

Again, Dr Jost, I think you did a great job with this presentation, and I thank the Society for the privilege of commenting on it.

Dr Corey J. Jost. Thank you, Dr Krupski, for your thoughtful and poignant critique.

In response to your first critique regarding the collage of this study, we felt it was important, because surgical intervention for venous disease is rarely performed. We report the entire group so that people have an idea of general overall patency or survival analysis of interventions for venous disease.

With regard to therapeutic or postoperative anticoagulation, we aim for a target of an INR of 2 to 3 in our patients, and all patients but one were discharged from the hospital on oral anticoagulation. Recommendations for lifelong anticoagulation were in all patients with PTFE grafts and/or patients with autologous reconstructions who have a history of hypercoagulability or previous recurrent deep venous thrombosis.

As far as the treatment algorithm goes, our first option in a patient who's a good operative risk, with significant persistent symptoms despite maximal conservative therapy is the Palma procedure. In patients who are good operative risks who do not have an adequate vein or some other contraindication to the Palma procedure, we do consider these other reconstructions.

In regard to functional assessment by plethysmography, we found this technique helpful in screening patients preoperatively for possible venographic evaluation. However, we were disappointed with our results in changes in patients after surgery, and we saw a small fraction of patients that had improvement to normal values with plethysmography. So we do not use this for a screening technique, but we use duplex ultrasonography.

As far as outcome analysis, the outcome that was expressed here was in terms of severity score as per the recommendations of the Joint Vascular Society. This outcome analysis is not dependent on the patients' perception of their care but actual scores based on venous ulceration, edema, and pain.

With concern of the control group, this is a small set of patients, and all of our patients had failed conservative therapy and presented for this reconstruction. It isn't a prospective, randomized study, but yet a descriptive one of this small group of patients.

And lastly, with your patient with symptomatic venous obstruction involving the iliac, common femoral, and superficial femoral vein, we would again treat this patient conservatively, initially. And if there was any acute aspect to her thrombosis, we would aggressively treat that. If the patient failed conservative mapping or had intractable symptoms and had an excellent saphenous vein on that affected extremity, we would consider a Palma procedure.

Dr Ronald Bays (Saginaw, Mich). I have a couple of questions. I think it would be helpful to have pressure data for these patients before and after your reconstructions. Is there a certain pressure gradient that you would use to perform a bypass, and is there a certain pressure gradient that would predict failure of the graft or remaining patency of the graft?

My second question is, if you have one of those ilio caval reconstructions and it subsequently thromboses, what do you do then?

Dr Jost. With regard to the first question, in a subgroup of the patients we did have preoperative and postoperative pressure gradient measurements. The mean preoperative pressure gradient was 10, and after reconstruction it was 4. I think a resting venous pressure of 10 would be considered a concern. That, coupled with positive plethysmography data and a venogram, would be an indication.

With regard to failure, our numbers are too small to really identify pressures because we only had that number in a subset to find out what is a pressure gradient that would identify a graft that's at risk for failure. However, as we mentioned, with our indications for placement of an arteriovenous fistula for the Palma procedure, we're concerned if there is a gradient less than 5.

Dr Bays. And if the graft thromboses?

Dr Jost. If the graft thromboses, we're aggressive in the early postoperative period. We return these patients for a thrombectomy. And also we did perform surveillance in the patients and found several grafts that needed revision.

Dr Herbert J. Robb (Orchard Lake, Mich). Because of your considerable experience with problems involving the vena cava, I would like to ask you a what-would-you-have-done question. It

was five o'clock in the afternoon. You were called to the operating room to assist with the problem. The patient had donated her right kidney for her daughter that morning. Bleeding had been difficult to control. The vena cava was now totally occluded at the level of the left renal vein. It looked as if the kidney donor would lose both kidneys and perhaps have many complications. To make a long story short, we moved 2 in of lower vena cava up to replace the occluded vein and attached the left renal vein to it. A Dacron graft was used to replace the lower vena cava. It did not thrombose. The patient has no complications. What would you have done?

Dr Jost. I think you've given an excellent description of what we would have done. I think that's a good reconstruction. And in that position, we anticipate that that graft would do well with the high flows.

Dr Peter F. Lawrence (Irvine, Calif). I enjoyed your presentation. Just one brief question about the patients who had a successful patent graft. You showed a dramatic picture of reduction of edema, but I can't help but comment about the amount of hyperpigmentation that appeared in that particular patient. My question relates to the aspects of the patient's initial indications that improve. Is it the swelling? Is it the pain? Is it the edema? I know that their clinical grades improve, but were there specific areas that improved and some areas that deteriorated that would lead to the hyperpigmentation that you showed?

Dr Jost. I appreciate the comment. Unfortunately, in that patient that preoperative image was obtained 2 years before reconstruction. I have a picture of him at reconstruction with a completely brawny limb, but not with that level of edema. So his lipodermatosclerosis and pigmentation had all occurred prior to reconstruction.